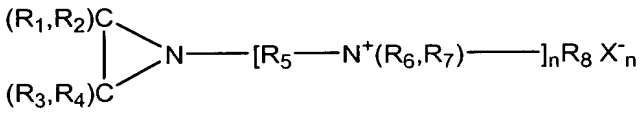
Claims

1. A method of selectively modifying nucleic acid molecules in a biological composition, said method comprising the step of contacting the composition with an inactivating agent having the formula:



wherein each of R_1, R_2, R_3, R_4, R_6, R_7, and R_8 is, independently, H or a monovalent hydrocarbon moiety containing between 1 and 4 carbon atoms, inclusive, provided that R_1, R_2, R_3, R_4, R_6, R_7, and R_8 cannot all be H; R_5 is a divalent hydrocarbon moiety containing between 2 and 4 carbon atoms, inclusive; X is a pharmaceutically acceptable counter-ion; and n is an integer between 2 and 10, inclusive.

2. The method of claim 1, wherein R_5 is alkylene and each of R_1, R_2, R_3, R_4, R_6, R_7, and R_8 is, independently, H or alkyl.

3. The method of claim 1, wherein R_5 contains 3 carbon atoms.

4. The method of claim 1, wherein each of R_1, R_2, R_3, R_4, R_6, R_7, and R_8 is H or a linear alkyl group.

5. The method of claim 1, wherein at least two of R_1, R_2, R_3, and R_4 are H.

6. The method of claim 1, wherein at least three of R_1, R_2, R_3, and R_4 are H.

7. The method of claim 1, wherein X is selected from the group consisting of chloride, bromide, iodide, acetate, and tosylate.

8. The method of claim 1, wherein n is 3 or 4.

9. The method of claim 1, wherein said biological composition is a cell-containing composition.

10. The method of claim 1, wherein said biological composition is selected from the group consisting of mammalian blood, purified or partially purified blood proteins, purified or partially purified blood components, blood cell proteins, blood plasma, platelet-rich plasma, a plasma concentrate, a precipitate from any fractionation of plasma, a supernatant from any fractionation of plasma, milk, saliva, serum, a cryoprecipitate, a cryosupernatant, a cell lysate, mammalian cell culture, mammalian cell culture medium, placental extracts, products of fermentation, ascitic fluid, and proteins induced in blood cells.

11. The method of claim 1, wherein the nucleic acid molecules are contained within a transforming DNA fragment.

12. The method of claim 1, wherein said nucleic acid molecules are contained within an infectious vertebrate virus.

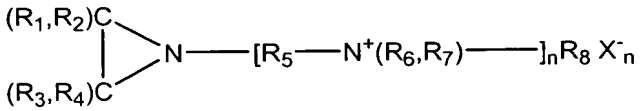
13. The method of claim 12, wherein the virus is selected from the group consisting of poxviruses, herpes viruses, adenoviruses, rubiviruses, flaviviruses, coronaviruses, paramyoxviruses, morbilliviruses, pneumonviruses, vesiculoviruses, lyssaviruses, picornaviruses, orthomyxoviruses, bunyaviruses, phleboviruses, nairoviruses, hepadnaviruses, arenaviruses, retroviruses, enteroviruses, rhinovirus, and the filoviridae.

14. The method of claim 12, wherein the virus is an enveloped virus.

15. The method of claim 12, wherein the virus is a non-enveloped virus.

16. The method of claim 12, wherein said inactivated virus comprises a killed virus vaccine.

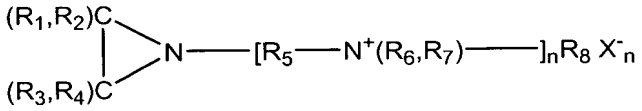
17. A killed vaccine comprising an effective amount of inactivated vertebrate virus and a pharmaceutically acceptable carrier, wherein said inactivated vertebrate virus is made by a process of incubating said virus with an inactivating agent under viral inactivating conditions, wherein said inactivating agent has the formula:



wherein each of R_1, R_2, R_3, R_4, R_6, R_7, and R_8 is, independently, H or a monovalent hydrocarbon moiety containing between 1 and 4 carbon atoms, inclusive, provided that R_1, R_2, R_3, R_4, R_6, R_7, and R_8 cannot all be H; R_5 is a divalent hydrocarbon moiety containing between 2 and 4 carbon atoms, inclusive; X is a pharmaceutically acceptable counter-ion; and n is an integer between 2 and 10, inclusive.

18. The killed vaccine of claim 17, wherein the viral inactivating conditions are effective to diminish infectivity by at least 20 logs by calculation.

19. A blood-collecting device comprising a container for receiving blood or a blood fraction, the container comprising an inactivating agent in an amount effective to inactivate viruses in the blood or fraction thereof received into the container, wherein the inactivating agent has the formula:



wherein each of R_1, R_2, R_3, R_4, R_6, R_7, and R_8 is, independently, H or a monovalent hydrocarbon moiety containing between 1 and 4 carbon atoms, inclusive, provided that R_1, R_2, R_3, R_4, R_6, R_7, and R_8 cannot all be H; R_5 is a divalent hydrocarbon moiety containing between 2 and 4 carbon atoms, inclusive; X is a pharmaceutically acceptable counter-ion; and n is an integer between 2 and 10, inclusive.

20. A method of selectively modifying nucleic acid molecules in a biological composition, said method comprising the step of contacting the composition with an inactivating agent having the formula:

$$\omega\text{-}X_1\text{-}[R_1\text{-}N^+(R_2, R_3)\text{-}]_nR_4 \cdot (X_2^-)_n$$

wherein X_1 is Cl or Br; R_1 is a divalent hydrocarbon moiety containing between 2 and 4 carbon atoms, inclusive; each of R_2, R_3, and R_4 is, independently, H or a monovalent hydrocarbon moiety containing between 1 and 4 carbon atoms, inclusive, provided that R_2, R_3, and R_4 cannot all be H when R_1 contains 2 carbon atoms; X_2 is a pharmaceutically acceptable counter-ion; and n is an integer between 2 and 10, inclusive.

21. The method of claim 20, wherein R_1 is alkylene and each of R_2, R_3, and R_4 is, independently, H or alkyl.

22. The method of claim 20, wherein R_1 contains 3 carbon atoms.

23. The method of claim 20, wherein each of R_2, R_3, and R_4 is H or a linear alkyl group.

24. The method of claim 20, wherein X_2 is selected from the group consisting of chloride, bromide, acetate, and tosylate.

25. The method of claim 20, wherein n is 3 or 4.

26. The method of claim 20, wherein said biological composition is a cell-containing composition.

27. The method of claim 20, wherein the nucleic acid molecules are contained within a transforming DNA fragment.

28. The method of claim 20, wherein said nucleic acid molecules are contained within an infectious vertebrate virus.

29. The method of claim 28, wherein the virus is an enveloped virus.

30. The method of claim 28, wherein the virus is a non-enveloped virus.

31. The method of claim 28, wherein said inactivated virus comprises a killed virus vaccine.

32. A killed vaccine comprising an effective amount of inactivated vertebrate virus and a pharmaceutically acceptable carrier, wherein said inactivated vertebrate virus is made by a process of incubating said virus with an inactivating agent under viral inactivating conditions, wherein said inactivating agent has the formula:

$$\omega\text{-}X_1\text{-}[R_1\text{-}N^+(R_2, R_3)\text{-}]_nR_4 \cdot (X_2^-)_n$$

wherein X_1 is Cl or Br; R_1 is a divalent hydrocarbon moiety containing between 2 and 4 carbon atoms, inclusive; each of R_2, R_3, and R_4 is, independently, H or a monovalent hydrocarbon moiety containing between 1 and 4 carbon atoms, inclusive, provided that R_2, R_3, and R_4 cannot all be H when R_1 contains 2 carbon atoms; X_2 is a pharmaceutically acceptable counter-ion; and n is an integer between 2 and 10, inclusive.

33. The killed vaccine of claim 32, wherein the viral inactivating conditions are effective to diminish infectivity by at least 20 logs by calculation.

34. A blood-collecting device comprising a container for receiving blood or a blood fraction, the container comprising an inactivating agent in an amount effective to inactivate viruses in the blood or fraction thereof received into the container, wherein the inactivating agent has the formula:

$$\omega\text{-}X_1\text{-}[R_1\text{-}N^+(R_2, R_3)\text{-}]_nR_4 \cdot (X_2^-)_n$$

wherein X_1 is Cl or Br; R_1 is a divalent hydrocarbon moiety containing between 2 and 4 carbon atoms, inclusive; each of R_2, R_3, and R_4 is, independently, H or a monovalent hydrocarbon moiety containing between 1 and 4 carbon atoms, inclusive, provided that R_2, R_3, and R_4 cannot all be H when R_1 contains 2 carbon atoms; X_2 is a pharmaceutically

acceptable counter-ion; and n is an integer between 2 and 10, inclusive.

35. A nucleic acid inactivating agent having the formula:

$$\omega\text{-}X_1\text{-}[R_1\text{-}N^+(R_2, R_3)\text{-}]_nR_4 \cdot (X_2^-)_n$$

wherein X_1 is Cl or Br; R_1 is a divalent hydrocarbon moiety containing between 2 and 4 carbon atoms, inclusive; each of R_2, R_3, and R_4 is, independently, H or a monovalent hydrocarbon moiety containing between 1 and 4 carbon atoms, inclusive, provided that R_2, R_3, and R_4 cannot all be H when R_1 contains 2 carbon atoms; X_2 is a pharmaceutically acceptable counter-ion; and n is an integer between 2 and 10, inclusive.

36. The inactivating agent of claim 35, wherein R_1 is alkylene and each of R_2, R_3, and R_4 is, independently, H or alkyl.

37. The inactivating agent of claim 35, wherein R_1 contains 3 carbon atoms.

38. The inactivating agent of claim 35, wherein each of R_2, R_3, and R_4 is H or a linear alkyl group.

39. The inactivating agent of claim 35, wherein X_2 is selected from the group consisting of chloride, bromide, acetate, and tosylate.

40. A method of selectively modifying nucleic acid molecules in a biological composition, said method comprising the step of contacting the composition with an inactivating agent having the formula:

$$\beta\text{-}X_1\text{-}CH_2CH_2\text{-}N^+H(R_1)\text{-}[R_2\text{-}N^+(R_3, R_4)\text{-}]_nR_5 \cdot (X_2^-)_{n+1}$$

wherein X_1 is Cl or Br; each of R_1, R_3, R_4, and R_5 is, independently, H or a monovalent hydrocarbon moiety containing between 1 and 4 carbon atoms, inclusive; R_2 is a divalent hydrocarbon moiety containing 3 or 4 carbon atoms; X_2 is a pharmaceutically acceptable counter-ion; and n is an integer between 2 and 10, inclusive.

41. The method of claim 40, wherein each of R_1, R_3, R_4, and R_5 is, independently, H

or alkyl, and R_2 is alkylene.

42. The method of claim 40, wherein R_2 contains 3 carbon atoms.

43. The method of claim 40, wherein each of R_1, R_3, R_4, and R_5 is H or a linear alkyl group.

44. The method of claim 40, wherein n is 3 or 4.

45. The method of claim 40, wherein X_2 is selected from the group consisting of chloride, bromide, acetate, and tosylate.

46. The method of claim 40, wherein said biological composition is a cell-containing composition.

47. The method of claim 40, wherein the nucleic acid molecules are contained within a transforming DNA fragment.

48. The method of claim 40, wherein said nucleic acid molecules are contained within an infectious vertebrate virus.

49. The method of claim 48, wherein the virus is an enveloped virus.

50. The method of claim 48, wherein the virus is a non-enveloped virus.

51. The method of claim 48, wherein said inactivated virus comprises a killed virus vaccine.

52. A killed vaccine comprising an effective amount of inactivated vertebrate virus and a pharmaceutically acceptable carrier, wherein said inactivated vertebrate virus is made by a process of incubating said virus with an inactivating agent under viral inactivating

conditions, wherein said inactivating agent has the formula:

$$\beta\text{-}X_1\text{-}CH_2CH_2\text{-}N^+H(R_1)\text{-}[R_2\text{-}N^+(R_3, R_4)\text{-}]_nR_5 \cdot (X_2^-)_{n+1}$$

wherein X_1 is Cl or Br; each of R_1, R_3, R_4, and R_5 is, independently, H or a monovalent hydrocarbon moiety containing between 1 and 4 carbon atoms, inclusive; R_2 is a divalent hydrocarbon moiety containing 3 or 4 carbon atoms; X_2 is a pharmaceutically acceptable counter-ion; and n is an integer between 2 and 10, inclusive.

53. The killed vaccine of claim 52, wherein the viral inactivating conditions are effective to diminish infectivity by at least 20 logs by calculation.

54. A blood-collecting device comprising a container for receiving blood or a blood fraction, the container comprising an inactivating agent in an amount effective to inactivate viruses in the blood or fraction thereof received into the container, wherein the inactivating agent has the formula:

$$\beta\text{-}X_1\text{-}CH_2CH_2\text{-}N^+H(R_1)\text{-}[R_2\text{-}N^+(R_3, R_4)\text{-}]_nR_5 \cdot (X_2^-)_{n+1}$$

wherein X_1 is Cl or Br; each of R_1, R_3, R_4, and R_5 is, independently, H or a monovalent hydrocarbon moiety containing between 1 and 4 carbon atoms, inclusive; R_2 is a divalent hydrocarbon moiety containing 3 or 4 carbon atoms; X_2 is a pharmaceutically acceptable counter-ion; and n is an integer between 2 and 10, inclusive.

55. A nucleic acid inactivating agent having the formula:

$$\beta\text{-}X_1\text{-}CH_2CH_2\text{-}N^+H(R_1)\text{-}[R_2\text{-}N^+(R_3, R_4)\text{-}]_nR_5 \cdot (X_2^-)_{n+1}$$

wherein X_1 is Cl or Br; each of R_1, R_3, R_4, and R_5 is, independently, H or a monovalent hydrocarbon moiety containing between 1 and 4 carbon atoms, inclusive; R_2 is a divalent hydrocarbon moiety containing 3 or 4 carbon atoms; X_2 is a pharmaceutically acceptable counter-ion; and n is an integer between 2 and 10, inclusive.

56. The inactivating agent of claim 55, wherein each of R_1, R_3, R_4, and R_5 is, independently, H or alkyl, and R_2 is alkylene.

57. The inactivating agent of claim 55, wherein R_2 contains 3 carbon atoms.

58. The inactivating agent of claim 55, wherein each of R_1, R_3, R_4, and R_5 is H or linear alkyl.

59. The inactivating agent of claim 55, wherein n is 3 or 4.

60. The inactivating agent of claim 55, wherein X_2 is selected from the group consisting of chloride, bromide, acetate, and tosylate.